

Management information for ecologically—oriented decision-making. A case study of the introduction of co-generation in eleven spanish companies

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Abstract

The purpose of this case study was to provide a report on the motivations which have led Spanish managers in the Galician region to take a green pathway. Such decisional processes may reflect a change in corporate consciousness, or it might be just another corporate response to increased political visibility and possible government intervention (Rodgers, 1991, 1992, Rodgers and Gago, 2001) The study focuses on eleven Spanish companies who instead of purchasing energy decided to produce their own energy using a co-generation system. A case study approach was selected in order to interpret the information provided concerning the adoption of a co-generation corporate strategy (Parker, and Roffey, 1997). Accounting information systems are considered to be important in this process as they select, classify and arrange information to inform their communities. Their design and implementation highlight environmental contingencies as they affect business entities' ability to operate. The results of the case study survey confirm that management benefit through cost savings and additional incomes. The article concludes by observing that the ecological implications of co-generation were not the primary motivation for adopting the 'green' innovation.

Introduction

In a changing global world economy the competitiveness of a firm depends largely on innovation in management and in technology.¹ This produces a sequence of effects such as a reduction in costs and an

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¹ Understanding by innovation, following Drucker's proposals (1994, 1998), an improvement, a new adaptation or new idea that allows the firm's resources to have additional capacity for generating revenue.

improvement in the quality of products and processes (Jeanne, 1997). Firms have also introduced social aspects into decision-making about innovations, particularly taking into account green implications (Florida, 1996). The manufacturing activity of companies may have different impacts on the environment, and it is the purpose of this study to discuss with management some of the various motivating factors. The aim of this study is to use a Spanish case-study as a means to explore the motivations of managers in implementing environmental information thereby extending our understanding of corporate attitudes toward the natural environment (see Gibson and Guthrie, 1995; Burritt and Lehman, 1995; Neu et al., 1998 and Everett and Neu, 2000).

Corporations may damage ecosystems by emitting pollutants, or improve their environment by using products and processes in ways which minimize damage to the natural environment (Hill, 1997). As Gray (1992, pp. 399) argued 'attempts to reintroduce protection and care for the environment into our thinking and into our ways of doing things leads slowly but inevitably to radical reconsideration of current attitudes, structures, beliefs and *modi operandi*'. Many industrial companies are now attempting to conserve and use natural resources in ways that do not degrade the environment (Rondinelli and Vastag, 1998; Wallace, 1995). This concern for ecological matters has important implications in decision-making with regard to innovations. Companies have three alternatives:

- To invest in technology minimizing the cost of dealing with pollution once it occurs;
- To prevent pollution by choosing technology which minimizes the negative effect of industrial activity on the environment;
- To integrate ecological aspects into the strategic process (Hutchinson, 1996).

The reasons for adopting a green mentality and pervasiveness in the firm are points for discussion. Levy (1997) affirms that the structures of related companies, corporate strategies and economies of substitute products and processes are factors that may explain the industrial support for an environmental policy. The aim of improving the corporate image is another factor to be considered. Environmentally-oriented policies are positively evaluated by clients, employees, suppliers and the public (Arora and Cason, 1996; Azzone et al., 1997b; Gray and Balmer, 1998). Ecological decisions may also respond to new environmental regulations for emission standards or charges, deposit refunds, performance bonuses and provision of information on pollution (Pigou, 1920; Nayserski and Tietenberg, 1992; Vickrey, 1992).

Some authors point out that emphasis on environmental aspects might divert attention from objectives which are really important for the survival of companies (see Walley and Whitehead, 1994). Many accounting authors, however, (Gallarotti, 1995; Makower, 1993) contend that ecological concern is certainly compatible with the objective of increasing corporate profits. The environment, therefore, may be a source of competitive advantages for corporations seen to be at the vanguard of reporting practice². Environmental accounting could be a source of additional value for shareholders making investments in green technology seem more attractive. This type of investment can therefore have a direct, or indirect impact on the cost structures and the revenue growth in both the short and long term (see Porter and Var der Linde, 1995). Savings in costs of purchased parts and components, waste disposal, quality improvements, extensions in capability, opportunities to develop new products, ecological product differentiation, increases in process yield, less downtime, lower packaging costs and safer products are examples of such benefits (Ayres et al., 1997; Hill, 1997; Reinhardt, 1998; Wycherley, 1995).

It seems obvious that accounting information should play a fundamental role in putting environmental management into practice in organizations (Gray et al., 1993). Accounting systems select, classify and arrange information for decision-making. Their design and set up may foster forms of development that take into account, or ignore ecological considerations. As Neu et al. (1998) explain accounting is a powerful technology which reports to relevant publics as a mechanism to interpret and inform communities about corporate policy. The accounting system, from this normative standpoint, has an obligation to establish mechanisms to:

- Detect points of environmental interest (for example, potential risk areas and means of generating profits or avoiding costs).
- Guarantee the reliability of the information provided to external and internal users.
- Collect data and publish the information.
- Support ecological decision-making (Tietenberg, 1997).

Reports on environmental performance, environmental budgets, waste product accounting, energy accounting or the cost of maintaining the

² Competitiveness represents the organization's ability to obtain and maintain advantages which allows it to achieve, support and improve a determined competitive position. Competitiveness implies the 'excellence' idea, together with the achievement of an increased ability to compete with other economic agents for market position. It also comprises an adequate functioning of the different operative units of organization (Porter, 1980, 1990; Shank and Govindarajan, 1993).

ecological capital are examples of accounting information following green standards (Gray, 1990; Gray et al., 1993; Owen et al., 1997; Schaltegger and Burritt, 2000).

Companies have traditionally focused on pollution control and prevention, mainly through cost approaches. Only recently have corporations begun to utilize the criterion of environmental productivity in any systemic manner. The primary managerial strategy is to establish a program to control the achievement of objectives and to review the adequacy of the products, processes, innovations, among other things together with their environmental policies (Azzone et al., 1997a; Porter and Van der Linde, 1995). The problem for accounting is to define the accounting information that measures how well the business is achieving these new targets. At this point, an acceptable solution has yet to be found in measuring, quantifying and reporting environmental contingencies to communities and their relevant publics. The question that we must keep in mind is why do managers' implement new environmental accounting technologies. Put differently, why does management implement new environmental technologies? (see Rubinstein, 1992; Everett and Neu, 2000).

Different philosophies underlie on the use of accounting information in decisional processes with environmental implications. There is no unique position in the environmental accounting literature. Different approaches explain why and how organizations face the environment and what role performs accounting on the change. The accounting literature varies from the organizational change to the institutional appropriation's thesis (see Larrinaga and Bebbington, 2001). The first approach maintains environmental accounting plays an active role in changing the attitude of organizations towards environment. The institutional appropriation model assumes that environmental considerations are not likely to change organizational views in a substantial way. In this article a Throughput Model (see Rodgers, 1991, 1992, Rodgers and Gago, 2001) provides a conceptual framework to analyze environmental decision—making.

The environmental innovation under analysis

The motivation guiding this study is to explore the decision-making processes whenever green innovations are considered by managers. It is argued that the main stimuli for the introduction of an environmental innovation must be to improve, or maintain, the firm's competitiveness. Because of the importance of the financial implications, the role performed by accounting information in this decision is critical. Accounting information, such as cost savings and revenue growth, derived from

the green innovation would need to be estimated before its implementation. The accounting information would then be used jointly with other quantitative and qualitative non-financial management data. Management and accounting information systems within the company would need to adapt their data bank to provide the necessary information about the ecological implications.

In Spain some companies have decided to produce their own energy using co-generation, instead of purchasing energy from an external supplier. Co-generation consists in the simultaneous production of heat and power into a single thermodynamic process, using a fuel (for example, petrol, biomass, or gas) as an input. The Combined Heat and Power (CHP) production has some important effects on the environment. It is one of the few technologies which can offer a significant contribution to energy efficiency. At the same time, it produces a positive impact on the atmosphere.

Primary energy savings are one of the benefits. It increases fuel efficiency by capturing energy that would be otherwise wasted. Conventional forms of generating energy only convert, on average, 30–40% of a fuel's potential energy into usable energy. Co-generation increases fuel efficiency by approximately 70%, giving energy savings of over a third. Moreover, the use of biomass and organic waste as a fuel source in co-generation allows companies to recycle materials that would otherwise be wasted thereby contributing to better utilization of the natural resources (CHP UK and the Projektbureau Warmte/Kracht, 1997; Elliot, 1997; European Commission, 1997b; Hill et al., 1994). Furthermore, co-generation results in significant reductions in emissions of pollutant gases in order to avoid atmospheric pollution and global warming (especially when biomass and organic waste are used as fuel)³. (European Commission, 1997a; Hill et al., 1994).

Although co-generation is now being actively promoted by European institutions⁴, its use in the European Union remains marginal. A study

³ In comparison with separate production of heat and electricity, the CO₂ savings from 1 Megawatt-hour of CHP electricity production range from 132 kg to 909 kg, with an average of 500 kg of saved CO₂ per Megawatt-hour.

⁴ In two European Council recommendations (1977, 1988) member states were invited to:

- Set up advisory bodies in order to determine measures that could increase the efficiency of the supply of heat, identify non-technical obstacles in the development of CHP systems and encourage CHP and heat transport schemes.
- Promote cooperation between public utilities and self-generators of electricity by removing legal and administrative obstacles (European Commission, 1997a).

More recently, the White Paper on energy (European Commission, 1997b) insisted on the need to promote this energy form, emphasizing its overall environmental benefit. The European Commission in 1997 presented the development of a strategy to promote and dismantle barriers to its development. The member states have introduced reforms in their legislation establishing incentives for adopting co-generation.

by the CHP UK and the Projektbureau Warmte/Kracht (1997) indicate that co-generation probably accounts for about 7% of electrical production⁵. The Spanish situation is below average. In 1993 CHP systems produced only 3% of the total gross electrical installed capacity (in Megawatts). It represented 5% of the total gross electricity generation (in Gigawatt-hours). These figures are significantly below averages obtained for European companies which were 13% and 9%, respectively (European Commission, 1997b).

Research method and the adopting companies

The eleven companies selected were located in Galicia, one of the seventeen autonomies comprising Spain. Moreover, these were the only companies which had implemented co-generation during the years 1995 and 1996 in the Galician area⁶. The selection of the companies to study was based on a list provided by the Ministry of Industry of the Galician government. It is also important to observe that co-generation was clearly supported by the government as a mechanism to reduce harm to the natural environment.

The government noted however that corporations must obtain profits in conjunction with environmental protection. Moreover, the companies showed a high degree of diversity. They were from varying industries, of various sizes and had different corporate structures (Table 1)⁷. Most of the firms were corporations (72.7%), whereas the others were limited-liability companies (27.3%). Eight of them were part of enterprise groups, with only three forming part of the same group⁸. The parent companies of half of the groups were located outside the region under consideration. The companies' industrial sectors were very diverse: wood boards, metallurgy, ceramics (bricks), wood pulp and oil refining. A continuous production process was utilized in all of them.

The technical characteristics of the CHP systems installed varied widely, as they included both simple equipment and more sophisticated systems. The fuels also varied, although kerosene dominated (Table 2).

To achieve a better knowledge of the co-generation decision-making, a case study approach was selected. The case study approach is relevant in that it explains and illuminates corporate motivations to implement

⁵ However, they point out that reliable and detailed statistics from the European Union on co-generation do not exist.

⁶ The first CHP in Galicia was operative in 1995.

⁷ There was no information about the value of sales and capital of one company. It was a part of a group which provided aggregate information related to the two member companies from Galicia.

⁸ Four groups specialized in one industry.

Table 1 – Companies involved in the study on co-generation

<i>Class</i>	<i>Sales (million Euros)</i>	#	%	<i>Employees</i>	#	%	<i>Capital (million Euros)</i>	#	%	<i>Type of company</i>	#	%	<i>Sector</i>	#	%
Small	Less than 12	3	27.3	Less than 75	3	27.3	Less than 1.5	3	27.3	Corporation	8	72.7	Wood boards	5	45.4
Medium	From 12 to 100	3	27.3	From 75 to 300	3	27.3	From 1.5 to 65	4	36.4	Limited-liability company	3	27.3	Metallurgy	2	18.2
Large	From 100 to 1000	4	36.4	From 300 to 750	5	45.4	From 65 to 900	3	27.3				Ceramic s (bricks)	2	18.2
													Wood pulp	1	9.1
No response	—	1	9.1	—	—	—	—	1	9.1				Oil refining	1	9.1

Table 2 – Types of CHP systems used in the study of corporation co-generation⁹

<i>Class</i>	<i>Kilowatt (nominal power)</i>	<i>#</i>	<i>%</i>	<i>Megawatt- year (production)</i>	<i>#</i>	<i>%</i>	<i>Fuel</i>	<i>#</i>	<i>%</i>	<i>Groups of fuel</i>	<i>#</i>	<i>%</i>
Small	From 675 to 8000	5	45.4	From 2000 to 55000	5	45.4	Kerosene	7	63.6	One	6	54.5
Medium	From 8000 to 24000	3	27.3	From 55000 to 100000	3	27.3	Gas	2	18.2	Two	4	36.4
Large	From 25000 to 38000	3	27.3	From 100000 to 390000	3	27.3	Others No response	1 1	9.1 9.1	No response	1	9.1

co-generation these companies. For reasons similar to these the Spanish government has worked in conjunction with companies seeking to protect the natural environment. The government, however, did emphasize that companies must obtain profits and their concern for the environment might be subordinate to financial motives.

When undertaking the interviews it was expected that the main stimuli would be to contribute to the firm's competitiveness. Clearly financial considerations and accounting information play an important role in the formulation of the decision process. This information, as is well-known, impacts on the ecological implications of the innovation. As preparation for conducting the research, a case study protocol was established in the summer of 1997 which specified research methodology (procedures, data collection techniques) and criteria to analyze and present the findings (Yin, 1994).

Using a grounded research method it was decided that personal interviews with the managers would provide a means to construct a richer picture to understand the motivations for implementing co-generation processes. Thus, managerial decision-making was used to as the main source of data allowing a broader picture of the decision-making process to be developed. Documentation, archival records and direct observation were used as complementary sources of information (Bruns and Kaplan, 1987; Yin, 1994). The criterion for interpreting the study's findings was to compare the results obtained from the companies. A linear-analytic structure was then used to compare the results of the survey (Yin, 1993, 1994; Parker and Roffey, 1997).

For the interviews with the managers, a questionnaire was developed. It consisted in a series of open-ended questions (see appendix). These

⁹ Notes resulting from interviews, direct observation, archival record study and document analysis formed a database (Yin, 1994). The database also included the documentation and tables utilized for comparisons. It is available for consultation.

questions were based on recent research using scientific data, theoretical developments in environmental accounting and the researcher's own background in management accounting. The questions which formed the basis of the questionnaire were not expressed in academic jargon so as not to confuse the interviewees (Bruns and Kaplan, 1987). The questions established general topics to be discussed during the meetings. The format stimulated discussions with the interviewees and the interchange of information (Yin, 1994).

The questionnaire acted only as a guide, assuring that the same issues were debated in all the interviews conducted in the eleven companies surveyed. The questions were not focused solely on ecological aspects to avoid directing, or limiting possible answers (McKinnon, 1988; Yin, 1994). This provided a means to allow managers to state the most important criteria that was used in their company and also acted to prevent interviewer biases (Yin, 1994).

The case study protocol required a meeting with the person, or people responsible for the CHP system. The most adequate spokesperson would be selected by the company as per the protocol. Only three of the interviewees came from Financial Departments (Table 3). The length of time the managers had been in the firms and in their current position varied widely. However, their training and experience in relation to the CHP systems were considered to be satisfactory for the purposes of the research. All were involved, directly or indirectly, in co-generation decision-making. Most of them were consulted about or took part in its implementation.

The first contact with the managers' was by telephone. The interviewees were only told the general purpose of the research (see earlier discussion). According to the protocol, they were not given a copy of the questionnaire. In five of the cases studied some additional information was sent by fax, or mail before the meeting¹⁰. Seven companies were very receptive to the visits. They considered the fact that University researchers were interested in their CHP systems as important. The ready acceptance in some firms was linked with a firm policy of facilitating interchanges with external agents such as the press and University. However, in four firms there were some objections to the meetings. The managers were hesitant and some argued that little would be gained from the visits.

¹⁰ The information required by fax included:

- formal identification of the interviewer as a member of the University,
- general purpose of the research,
- how much time it would be necessary to invest in the meetings,
- precise issues to be discussed.

Table 3 – Spokespeople interviewed in regard to CHR systems

<i>Position</i>		<i>Male vs. Female interviewees</i>		<i>Years in firm</i>		<i>Years in the current position</i>		<i>Degree*</i>	
President	4	Male interviewees	12	Less than 5	2	Less than 5	6	University degree in Business and/or Economics	5
Vice-President Finance	3			From 5 to 10	3	From 5 to 10	3	University degree in Engineering	4
Vice-President Personnel Training and Firm Security	1			From 15 to 20	2	From 10 to 15	1	University degree in Law	2
Vice-President CHP System	1			From 20 to 25	4	From 20 to 25	1	University degree in English	1
Vice-President Production	1	Female interviewees	1	From 25 to 30	1	From 25 to 30	1	Degree in Economics from other institution	1
Vice-President Research and Development	1			No response	1	No response	1	Degree in Naval Machinery from other institution	1
Head of the Auxiliary Services Department	1							No response	1
Head of Institutional Relationships	1								

*Two interviewees had two university degrees: one in Economics and Business Administration, and the other in Law and English.

Interviews were carried out from the summer of 1997 until the spring of 1998. The total number of visits to the companies was nine (the same person answered questions about three firms)¹¹. The format of the meetings was dictated by the companies. Five of the visits consisted of a meeting with only one manager. The other four were based on meetings with two managers. In two of the firms there were joint meetings with two managers whereas in another two the meetings were individual and consecutive. One of the joint meetings was with the President of the Company and the Vice-President of Finance. In the other two Vice-Presidents participated.

Each meeting was conducted according to the agreed procedures in the protocol (Yin, 1994). They reviewed the purpose of the meeting, its scope and confidentiality. Adequate time and attention to the interviews and the interviewees were dedicated. The average length of the interviews was two hours. The interviews were informal conversations. Each manager was encouraged to speak freely and to discuss the topics openly (Purdy and Gago, 2002). In order to capture their interest and facilitate information exchange, adequate time for answers was allowed. Active listening was used to ensure accurate feedback and to avoid possible misunderstandings (McKinnon, 1994). It also was a means to demonstrate the questioner's interest in the conversation (Yin, 1994). However, the interviewer avoided directing the answers. The interviewees did not allow the use of tape recorders. This was expected by the protocol. To assure accuracy, while the managers were speaking, written notes were taken in an easily visible place (Yin, 1994). The interviewees read the notes and observations written. They made observations about the notes, stating their agreement or disagreement with them. Notes were modified following their indications because of confidentiality or hesitance to divulge information. They were reluctant to provide detailed strategic internal information connected with the CHP, especially quantitative data. The managers were eager to speak about co-generation. At times they contradicted themselves. However, there was no reason to believe that the managers had been anything other than sincere. After completing the questions specified by the protocol, all of the managers were given an opportunity to speak about co-generation. Additional time was also dedicated to an informal exchange of ideas (Bruns and Kaplan, 1987).

In the joint meetings the debate was stimulated without interfering in it (McKinnon, 1994). The interviewer acted as a moderator and tried to avoid that hierarchical differences might influence the answers (Yin,

¹¹ This manager participated in the whole process of decision-making connected with co-generation in the three companies, which were members of the same group. He was asked about the specific differences among the three companies in relation to the CHP systems.

1994). Such cautions proved to be adequate. The managers openly debated between themselves about relevant topics. Most of the time consensus was achieved. At times they maintained opposite opinions. In this case both points of view were reported.

In this type of research confidence in the interviewees is necessary (Purdy and Gago, 2002). With the aim of motivating the managers to speak freely and honestly, they were given two guarantees during the meetings:

- The commitment not to reveal information that allows the identification of specific companies.
- The managers could revise the output of the research before presenting it in any public forum.

Documentation, archival records and direct observation were also used to collect additional data (Yin, 1994). The documentation consisted in letters, faxes, internal reports, scientific and newspaper articles and published laws. Additionally an investment project on co-generation was utilized. They were consulted before, during and after the field research. Sources included: governmental institutions, banks, scientific journals, newspapers and the companies themselves. The documentation corroborated the evidence obtained by the interviews. The archival records used were:

- Three computerized databases referring to financial and structural information from the leading companies in Galicia;
- A regional census record of the companies who had authorized co-generation from 1995 to 1998 was provided by the Galician Ministry of Energy. It included technical information about the Galician CHP systems.

Observation was a useful way to obtain additional information about co-generation. It increased the understanding of the problems in decision-making in CHP. It also was helpful to highlight the organizational context. During one visit a CHP installation was visited. Technical personnel explained how the system ran, contributing to a better comprehension of its nature.

Results

Decision on co-generation

From the questionnaire information one conclusion is that the majority of the companies (90.9%) stated that their decision-making processes were based on financial considerations. They made their decision to implement co-generation on financial criteria. Decision-making on co-generation was no exception. It became clear that benign concern

Table 4 – The extent to which companies need to reform operations to achieve aims of environmental accounting

<i>Areas of forecast impact</i>		<i>Companies that mentioned it</i>	
		#	%
Production of energy for self-consumption	1. Savings in energy costs	10	90.9
	2. Improvement in processes	8	72.7
	3. Improvement in input	1	9.1
Avoiding negative environmental impact		3	27.3
Production of surplus electricity for selling		3	27.3

for environmental factors were not the reason which guided the decision-making process. From an ethical perspective, it can be summarised that these companies assumed a utilitarian position.

One firm, however, provided a different management decision-making approach which selected a technology with positive environmental repercussions. This company was contaminating the environment through its production process and they searched for green technologies to reduce the amount of pollution they generated. The company stated that the main attraction of selecting co-generation was its environmental impact. The financial impact was also significant. The company was motivated to act appropriately (perception towards the importance of environment). That motivation influenced the information set used to be analyzed (judgment) when the implementation of co-generation was decided.

Multiple reasons for adopting co-generation were highlighted by the companies. All of them stated that the anticipated financial benefits derived from the self-production of energy were one of the principal reasons. Co-generation was “good” because it was profitable and it also caused a positive green effect, confirming the utilitarian viewpoint. Once again, these results indicate the extent to which companies need to reform their operations if they are to achieve the aims of environmental accounting (Table 4).

The main financial advantage of the innovation in ten companies was the expected savings in energy costs as compared to buying energy from an external supplier. This was not the only possible benefit detected relating to energy. The heat obtained from the CHP systems could be used in their production processes. It could improve the utilization of raw materials (one company) or to contribute to a better running of the production processes (eight companies). Both aspects would produce an

increase in the quality of the products and the processes, offering the opportunity to develop competitive advantages.

Furthermore, the introduction of co-generation was considered to be a means to prevent negative environmental impact. Creating pollution could also have financial repercussions. In three companies the CHP system was a solution to the need to protect the environment. It allowed them to recycle materials and to avoid waste disposal. The impact of recycling was not very significant financially for two of the firms. It was important, however, from a non-financial point of view. For the third company, the ecological impact was financially considerable. The CHP system implementation avoided the payment of a large penalty for contamination.

Three companies saw the CHP systems as an opportunity to develop a new line of business by the external sale of surplus electricity. It was regarded as a profitable alternative, as government policies promoted co-generation and offered financial incentives. However, those sales were not their main motivation. In conclusion, the companies found multiple financial and ecological reasons that justified the advantages of introducing co-generation. The financial reasons, and among them the savings in energy costs, were regarded as the most important selection criteria. The finding that only one company evaluated environmental concern as its main motivation for adopting co-generation demonstrated that environmental considerations were secondary to financial motives.

Information evaluated in decision-making on co-generation

Cost savings

Cost analysis covered many different aspects necessary to evaluate the interest of co-generation in financial terms (Table 5). Thus, ten companies determined the associated energy savings. For them, the cost of energy was significant in relation to the overall cost of the product. However, there was a wide variation in such importance. It oscillated from 3.5% to 50%.

To value cost savings in energy, companies predicted the cost of producing heat and power:

- The quantities of inputs and outputs were calculated by electrical and calorific studies.
- The needs of personnel, raw materials and other costs necessary were forecasted by engineering and financial methods.

Table 5 – Forecast of costs to evaluate the interest of co-generation

<i>Forecast of costs affected</i>	<i>Companies</i>	
	#	%
Energy saving (power + heat)	10	90.9
Drying of the raw material	5	45.4
Waste products	3	27.3
Recycling of materials	3	27.3
Improvement of stability in the process	1	9.1
Raw material costs	1	9.1
Penalty saving	1	9.1
Pumping water savings	1	9.1

The amount to be invested in the CHP plants was determined from offers of different firms. The smaller plants required an investment of between 300 and 360 thousand Euros. The larger companies slightly less than 50 million Euros. Their estimate proved to be accurate¹². Such costs were compared with the external suppliers' prices. As a result of the comparison, cost savings in heat and electricity were identified. Their impact in the total cost of energy varied into two well-differentiated intervals: between 31% and 57% (four companies) and between 6% and 14% (three companies).

The forecasted cost savings were also a consequence of an increase in the efficiency in the running of the production processes. The heat allowed five companies to improve the performance of their drying processes. In consequence, they anticipated a decrease in the products' costs. One company linked those savings to a better utilization of raw materials. The foreseeable savings represented 30% of the overall cost of its product.

Furthermore, there were other types of cost items affected. The CHP system contributed to the stabilization of the production process in one company. It was affected by power cuts in the electricity coming from the external suppliers. And co-generation could reduce considerably the number of stoppages.

Another possible source of cost savings was the environment. Five companies considered that co-generation could have the following beneficial effects:

¹² Many of these CHP systems installed electric generation equipment, a turbine or engine, using a waste heat recovery boiler to capture the heat. The captured heat could then be used to satisfy heating requirements. It provided cooling using absorption cooling technology, and even generated more electricity with a steam turbine. The systems could satisfy compressed air requirements by bleeding high-pressure air off the compressor stage of a combustion turbine.

- Provision of energy for purification of waste products (three companies).
- Recycling of materials for production processes because purified waste could be used as fuel (three companies).
- Savings as a result of not having to pump water to purify wastes (one company).
- Avoiding the payment of a penalty for contamination. The CHP system also guaranteed that the company would not stop manufacturing due to this penalty (one company).

Essentially the environmental cost savings were connected to the possibility of recycling materials and purifying waste products. The use of biomass as fuel in three firms was important from an ecological point of view. However, its impact on cost was only significant in two companies. Co-generation also allowed them to reduce the environmental impact in terms of waste products to a negligible level. Before the introduction of the innovation, the material was dumped without rigorous purification. The CHP systems made recycling these materials possible and eliminated some impurities.

As was pointed out previously, one company was interested in this innovation to avoid paying a penalty for contamination. Its production process had an important negative effect on the environment. It spilt waste into a nearby river. The new laws of environmental protection not only would punish it financially but also they could even force it to stop its activities. This was avoided by using the CHP system while it is possible to say that the information used to evaluate the interest of co-generation considered the possible cost savings. The areas with cost savings were energy, production processes and materials. The ecological consequences of the innovation were seen as a source of cost savings in such areas.

Additional income

Most of the companies thought that the sale of the surplus energy, remained after the consumption of electrical energy, was a source of additional income (Table 6). The importance attributed to it was varied. Four firms stated that the income achieved would be minimal. One company recognized that it would make up over 16% of its total incomes, being a complementary source of benefits. None of the companies viewed it as an important line of business. However, during the meetings some managers affirmed that other visited firms were interested in co-generation solely for the potential incomes from selling surplus energy. This assertion could not be proven, as all the managers denied that it happened in their firms.

Table 6 – Rate of additional income gained from excess energy produced

<i>Was any additional income by selling the surplus forecasted?</i>	<i>Companies</i>	
	#	%
Yes	9	81.8
No	1	9.1
No response (it was a decision made by the parent company)	1	9.1

The way to estimate the possible additional income was similar. Once internal consumption had been determined by engineering and financial calculations, the remainder was used to forecast the quantity to be sold. The selling price for surplus electricity was determined in accordance with government rates. This price consisted in remuneration based on the principle of avoided costs.

The Spanish authorities, following European Union policies in this area, had introduced the legal obligation that the nearest supplier of energy with appropriate technical and financial characteristics had to buy the surplus energy at a guaranteed price (real decreto 2366/1994). The purpose of the legislation was that the possible surplus energy generated should not be seen as a discouraging factor by the companies that had to assume its cost. The sale of the surplus energy was profitable as a result of such government incentives. However, the companies anticipated a reduction in such incentives as soon as co-generation became more common.

Profitability, financing, risk and environmental impact

Most of the companies considered co-generation to be profitable (Table 7). Nine of them referred to its financial profitability. However, for one firm the profitability was derived from the increased stability in the running of its production processes. Co-generation provided them homogeneous conditions and avoided cuts in the electricity supply.

In terms of financial viability, the investment project had an average payback period between three and five years¹³. It was also foreseen that the financial viability would depend largely on the legislation that regulated aspects such as its price.

Seven companies stated that the best means of financing the CHP system was a combination of external and internal financial sources (Table 7).

¹³ Similar results were obtained by Hill et al. (1994) in their analysis of a hotel group (pay-back period of 2.5–3 years), whereas Southern Water Services Ltd. estimated a payback period of 5–6 years.

Table 7 – Profitability of co-generation

<i>Profitability</i>	<i>Companies</i>		<i>Financial sources</i>	<i>Companies</i>	
	#	%		#	%
• Highly profitable	5	45.45	• Mixed:		
• Profitable	5	45.45	1. Predominance of external over internal	6	54.5
			2. Not specified	1	9.1
			• Only internal	1	9.1
			• Only external	1	9.1
			• Leasing	1	9.1
No response (it was a decision made by the parent company)	1	9.1	No response (it was a decision made by the parent company)	1	9.1

The former, which included a participation of state subsidies, varied between 60% and 86%. The latter ranged from 14% to 40%. One company decided to create a new firm to deal with the sale of surplus energy. Its capital was 14% financed by the firm itself and the rest by the government (specifically by the Institute of Cost Energy Savings Development). The new company obtained benefits from two sources. It sold energy to the company according to a negotiated transfer price. It also provided the surplus energy to external electrical companies at the official price. The group evaluated this investment as highly profitable.

Most of the companies considered that the investment was of medium or low risk (Table 8). Only one company evaluated it as being without risk. Its lack of risk was justified by the expected benefits obtained and the financial structure selected (mainly composed of government subsidies).

The origins of the risk varied widely:

- Three companies associated the risk with possible changes in legislation and in costs of fuel. That cost would oscillate because of possible increases in the prices of the fuel market. It also would change because of fluctuations in the exchange rate between the Euro and the US dollar, the currency in which such market traded.
- Being the pioneers in their sector or area in Galicia was pointed out by three companies as a risk factor. Without having access to previous information the risk assumed at the time of decision-making increased. This risk was estimated as high by one of them as it was the first operative CHP system in the region.

Table 8 – Estimated risk of co-generation

<i>Risk</i>	<i>Companies</i>		<i>Environmental impact</i>	<i>Companies</i>	
	#	%		#	%
Evaluated risk:					
• High	1	9.1	Positive	6	54.5
• Medium	5	45.4			
• Low	3	27.3			
Without risk	1	9.1	Negative	2	18.2
No response	1	9.1	Without impact	2	18.2
(it was a decision made by the parent company)					

- The decision to rely on a construction company that had never built a CHP plant was mentioned by one company. However, it estimated that the sale of surplus electricity was guaranteed and that the principal benefit was cost savings. For this reason, the firm decided that the overall risk was low.

Most of the companies anticipated a significant effect on the environment: positive (six companies) or negative (two companies) (Table 8). Only three of them considered this impact to be relevant when deciding on whether to use co-generation. To evaluate the ecological impact, they took into account the pollution that they might produce, mainly by gas emissions and acoustic contamination. They decided to adopt all the measures required under Spanish laws to reduce pollution. These measures included filters for sulfur, noise insulation and control for the emission of gases into the atmosphere. The positive impact on the environment was linked to different areas. The elimination of waste and the positive balance in energy that might be achieved after introducing co-generation were evaluated as important or very important.

To sum up, it is possible to affirm that co-generation was profitable mainly from a financial point of view. External financing with state subsidies was found to be the most common means of financing the CHP systems. The risk was acceptable and the forecasted ecological impact positive in most cases.

Sources of information on co-generation and its benefits

Information on the existence of co-generation and its importance as an innovation that produced significant benefits came from different sources (Table 9). The most common source was the observation of its

Table 9 – Sources of information on co-generation

<i>Knowledge of the innovation came from . . .</i>	<i>Companies</i>	
	<i>No.</i>	<i>%</i>
• Other companies	8	72.7
• Congresses	1	9.1
• Legislation	1	9.1
• No response (it was a decision made by the parent company)	1	9.1

successful application in other companies. In this sense, seven companies stated that the possible benefits of co-generation were detected in other Spanish or foreign companies. Such companies were developing competitive advantages as a result of this innovation. To obtain further information by direct observation of the CHP systems, visits to those firms were agreed upon. Meetings with their managers were a useful means of achieving reliable information. Based on the information collected, it was confirmed that co-generation was a feasible alternative.

There were other sources of information on co-generation:

- Through the President, who attended several national and international congresses on co-generation, motivating a deeper analysis of the specific advantages of introducing a CHP system (one company).
- Government incentives created a favorable environment for the introduction of co-generation (one company).
- An external company specialized in the analysis of the profitability of CHP systems (one company).

After obtaining general knowledge about co-generation, the companies selected and classified additional information to evaluate its specific interest. Such information demonstrated the aspects in which the CHP system contributed to generating, improving or maintaining advantages over competitors. This information was not always provided by internal management and accounting systems (Table 10)¹⁴. Dealing with new concepts made it necessary to rely on external companies with experience in evaluating such projects. Co-generation was an innovation. There were no companies with years of experience of handling CHP systems in the region. Thus, it was crucial to obtain reliable information from experts in the field. This aspect was also important to the firms that used both internal and external sources of information.

¹⁴ The final decision of introducing co-generation was made at the maximum level of responsibility by the President.

Table 10 – Sources of information on co-generation

<i>The information used to evaluate the interest of the innovation came from . . .</i>	<i>Companies</i>	
	#	%
Internal and external sources	4	36.4
Only internal sources	4	36.4
Only external sources	3	27.3

The information on the existence of co-generation was obtained through different sources. The management information used to decide on the introduction of co-generation was provided not only by the management and accounting information systems but also by external systems. The need to find new information was crucial in their decision to rely on external sources of information. The companies did not possess an extensive enough data bank to cover all the anticipated information requirements (so how did they decide and/or make their decision. They make their decisions based on the reports elaborated by consultants, banks, etc.—the external sources).

Summary and conclusions

This study concerned the decision-making processes used in introducing a green innovation in eleven adopting Spanish companies. Using ideas central to the emerging environmental accounting literature it was anticipated that companies would take into account ecological implications when there was a possibility of improving corporate competitiveness. They had a direct or, indirect impact on cost structures and revenue growth both in the short and the long term. The Spanish case, in this regard, therefore provides some evidence that corporations utilise environmental accounting for corporate considerations rather than ecological purposes.

As management and accounting systems are tools that provide information that detects means of developing and maintaining competitive advantages, the information provided by such systems should play a fundamental role in the decision of whether or not to introduce an innovation with ecological consequences. The special nature of this information required an adaptation of such systems to anticipate the possible green benefits derived from the innovation.

The companies studied had introduced the same environmental innovation in 1995 and 1996 in a Spanish region called Galicia. The environmental innovation was the use of co-generation to generate energy for internal consumption. Co-generation produced a positive

effect on the environment by energy savings, recycling of materials and reduction of pollution. The companies were from varying industries, of various sizes and had different corporate structures. They were a good representation of business reality in Galicia¹⁵. Their extremely reduced number made it difficult to select a research method for generalizing and extrapolating conclusions from the findings. The small size of the sample discouraged a statistical analysis in the study.

Using ideas central to the emerging environmental accounting literature it was anticipated that companies would take into account ecological implications when there was a possibility of improving corporate competitiveness in six different ways. They were: psychological egoism, deontology viewpoint, relativist perspective, utilitarian position, virtue ethics outlook and ethics of care philosophy. The Spanish case, in this regard, therefore provides some evidence that corporations utilize environmental accounting for corporate rather than ecological purposes. More particularly, the findings showed that decision-making was mostly based on financial considerations which illustrated the essentially technical and utilitarian position that companies adopt. Only one company declared that it considered environmental criteria before financial aspects. This company, it can be argued, followed a virtue ethics outlook in their decision-making processes concerning co-generation. It also examined the financial impact in their decision-making. Thus, in most of the companies, this decision was based mainly on profit/financial motives and not on respect for the environment. In general, there were no ecological attitudes, structures, beliefs and *modus operandi* of the companies in co-generation's decision-makings. Savings in energy costs and improvement in processes were pointed out as the main benefits of co-generation for most of the companies.

In sum, then, the findings of the case-study showed that the information used to decide on co-generation was mainly accounting information on costs and incomes. The information included:

- cost savings (in energy, drying of materials, waste, recycling of materials, stability in the process, raw materials, cost opportunity because of avoiding a penalty, pumping water),
- revenue growth (derived from the previous cost savings and the sale of surplus electricity which was seen as a marginal way to obtain additional profits),
- financial viability,

¹⁵ Galicia has a dense network of small companies in which there are some larger companies, which are not well connected with the smaller companies (López Facal, 1996).

- state subsidies,
- the risk factor.

This financial information was used jointly with other quantitative and non-quantitative management information related to the environmental impact of co-generation (stabilization of processes, avoiding a possible negative ecological repercussion, reducing waste, and preventing pollution). There were no similar case studies focused on co-generation available from other Spanish and European firms. Thus, a comparison of results was not possible. However, the findings obtained were in accordance with part of the prior theoretical and empirical research in the environmental and the CHP fields.

Future research could profitably focus on the accounting change approach to analyze accounting information on co-generation is affected by organizational variables (such as culture, organizational structure, strategies, style of management, incentive systems, production processes and the environment). The evolution of one organizational variable exerts its influence on other organizational variables in such a way that there are continuous inter-relationships in a dynamic context. Analysis of this process will provide a better understanding of the impact that an environmental innovation has on companies.

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Appendix—questions

1. What was the innovation?
2. How did the idea arise?
3. How was the decision to adopt this innovation taken?
 - a) Was the decision made by an individual or a group of people?
 - b) Who was consulted?
4. What were the areas forecasted to be effected by co-generation?
5. What was the most important reason causing the decision to introduce the innovation?
6. Was an external firm contracted to make a study to evaluate the innovation's advantages? What importance was given to this information?
7. Speaking specifically about the information used to evaluate the advantages of the innovation for the firm:
 - a) What types of costs would be affected?
 - b) What were the estimated cost savings? (It is not necessary to give sums in pesetas, percentages are acceptable)
 - c) What types of additional income would be generated?
 - d) What was the importance of that income? (It is not necessary to give sums in pesetas, percentages are acceptable)
 - e) What type of investments was necessary?
 - f) How much were these investments? (It is not necessary to give sums in pesetas, percentages over total assets, or sales, or some other indicator of the activity, are acceptable, please, state which)
 - g) Which type of financial sources was deemed the most suitable: internal sources or external sources?
 - h) If possible, state the profitability established for the innovation. If this is not possible then, rank if it was evaluated to be very profitable, profitable, or of low profitability
8. What were the criteria used to determine the following information?
 - a) costs
 - b) additional income
 - c) investments
 - d) financial sources
 - e) profitability
 - h) risk
 - i) environmental impact
9. After the innovation, did you discover differences between real costs and forecasted costs?
 - a) What were these differences?
 - b) How much were these differences (percentages are acceptable)?
 - c) To what were they due?
 - d) Were they qualified as justifiable? Why?
10. After the innovation did you discover differences between real additional incomes and those forecasted:
 - a) What were these differences?
 - b) How much were these differences (percentages are acceptable)?
 - c) What were they accounted to?
 - d) Were they qualified as justifiable? Why?
11. After the innovation, did you discover differences between real additional investments and those forecasted?
 - a) What were these differences?
 - b) How much were these differences (percentages are acceptable)?
 - c) What were they attributed to?
 - d) Were they qualified as justifiable? Why?

Continued

12. After the innovation, did you discover differences between real financial costs and those forecasted?
- a) What were these differences?
 - b) How much were these differences (percentages are acceptable)?
 - c) What were they accounted to?
 - d) Were they qualified as justifiable? Why?
13. After the innovation, did you discover differences between the real environmental impact and that forecasted?
- a) What were these differences?
 - b) What were they attributed to?
 - c) Were they qualified as justifiable? Why?
14. How was the process controlled: in an informal way or by reports? In the latter case, indicate the type of information included in these reports.
15. Who is responsible for the control and what does his work consist of?
16. What role did accounting information play in the process of implementing the innovation?
17. Were/are there any difficulties regarding information for the implementation of the innovation and its control? (I.e. any information that you wanted/want to have and you could/can not obtain?).
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